

Why Europa?

Few bodies in the solar system have attracted as much scientific attention as Jupiter's moon Europa, and it's easy to understand why. Despite the fact that it is the sixth largest moon in our solar system, Europa is an enigma. It presents us with more questions than answers, and as the nature of science is to ask questions, Europa has become the object of intense scientific investigation.

The Voyager encounters provided our first close-up images of Europa, revealing bright blue icy plains intermixed with red and brown mottled regions. Cracks that run for thousands of kilometers over the moon's surface confounded scientists. On Earth, such extensive features--mountains, trenches, and canyons--would show considerable topography. On Europa, however, nothing exceeds a few kilometers in height, and very few landforms exceed a few hundred meters in height, which makes it one of the smoothest objects in our solar system.

Yet if we look at this icy moon's surface more closely, as the Galileo spacecraft has allowed us to, a variety of intriguing features become apparent. Europa's surface has the appearance of a broken pane of glass, its shards repaired by an icy glue from below. Low ridges, some straight, some curved, crisscross the surface. Flows and fractures, pits and frozen "puddles," all suggest a unique geologic history. Large circular features could be the sites of impacts, or result from the upwelling of material from below. Making sense of this chaotic landscape is a challenge to planetary scientists.

Although the surface of Europa is a jumble of curious structures, it is the kind of puzzle that science can probably solve. The questions we ask are very simple ones: "How old is the surface? How were the cracks and other features made? What lies below the ice?" To answer them we collect data and make careful observations, applying what we know about geology, physics, and chemistry. In a way, the instruments on board Galileo become an extension of our senses.

Geologists determine the relative age of a surface by counting the number of impact craters. The Earth's moon is riddled with craters young and old, testimony to the fact that it has been geologically inactive for a billion years or more. Earth itself has been impacted at least as many times as its moon, but Earth's surface has been altered by active geological processes such as plate tectonics and volcanism, and by constant weathering. Like our own moon, Jupiter's satellites Ganymede and Callisto are heavily cratered, evidence of very old and inactive surfaces. On Europa, however, only a few large craters have been identified. Unless Europa has somehow avoided these impacts, relatively recent events must have erased their signatures.

Looking at the images returned by Galileo, we see evidence of geologic action. Small blocks of crust seem to float like icebergs over an invisible sea. Some are tilted, others rotated out of place. Dark bands of ice and rock appear to spread outward from a central ridge. If we step back and view the entire surface, the largest fractures seem to be

oriented in a pattern that is far from random. What is the cause of this pattern?

In a gravitational tug of war of incredible dimensions, Europa is pulled in different directions by Jupiter and its other moons. Over the period of one European day, it is alternately extended and compressed. The outer surface of Europa, however, is an unforgiving, rigid sphere. Imagine the Earth's surface covered by a blanket of ice with the oceans, trapped below, rising and falling as the moon orbits above. The flexing of Europa's surface continues until the brittle crust cracks. What happens when the crust fractures is unknown. The process may be slow and steady, advancing only centimeters at a time. On the other hand, it may cause ice volcanoes or geysers to erupt violently, showering the surface with material from below.

Another interesting possibility arises from the "tidal flexing" of Europa. Some scientists have suggested that heat generated by the expansion and contraction may be enough to melt the icy crust at depth, creating lakes or oceans below the surface. The possibility of liquid water just below Europa's surface naturally leads to the question of whether life could have evolved there. The discovery of marine communities on Earth that thrive in the deep ocean near hydrothermal vents provides us with a model for how similar organisms might survive on Europa. While the existence of liquid water beneath the surface would add one of life's key ingredients, we know that many other factors, including organic material and a continuous energy source, need to be present. Even if there is no ocean currently on Europa, however, one may have existed in the past, possibly leaving fossilized remains to be found by a future mission.

Just as "you can't judge a book by its cover," much of the story Europa has to tell lies below its surface. Perhaps if we gaze at it long enough, Europa will, like a crystal ball above the surface of Jupiter, give up its secrets.

Or perhaps we should go there ourselves.